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First Named Inventor	Ahmad Ghaemmaghami
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Examiner Name	Jose R. Diaz
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Amended Supplemental Appeal Brief

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E0545 PATENT

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Ghaemmaghami et al.

Serial No.: 09/497,320

Filed: February 3, 2000

Group Art Unit: 2815

Before the Examiner: Jose R. Diaz

Title: METHOD AND SYSTEM FOR PROVIDING HALO IMPLANT TO A SEMICONDUCTOR DEVICE WITH MINIMAL IMPACT TO THE JUNCTION CAPACITANCE

AMENDED SUPPLEMENTAL APPEAL BRIEF

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I. REAL PARTY IN INTEREST

The real party in interest is Advanced Micro Devices, Inc., which is the assignee of the entire right, title and interest in the above-identified patent application.

CERTIFICATION UNDER 37 C.F.R. §1.8

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II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellants, Appellants' legal representative or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1, 4-8, 11, 12 and 14-20 are pending in the Application. Claims 15-17 are allowed. Claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 stand rejected. Claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 are appealed.

IV. STATUS OF AMENDMENTS

Appellants have not submitted any amendments following receipt of the final rejection with a mailing date of June 3, 2004.

V. SUMMARY OF CLAIMED SUBJECT MATTER

In one embodiment of the present invention, a method for providing a halo implant to a semiconductor device may comprise the step of providing a thin photoresist layer to the semiconductor device that covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device. Specification, page 5, line 6; Specification, page 5, lines 10-13; Figure 3, step 308; Figure 4, elements 400, 402, 404 and 406. The method may further comprise providing the halo implant to the semiconductor device, where the thin photoresist layer is used as a mask. Specification, page 5, lines 6-9; Figure 3, step 308; Figure 2, element 202; Figure 4, element 400.

In another embodiment of the present invention, a system for providing a halo implant to a semiconductor device may comprise means for providing a thin

photoresist layer to the semiconductor device, where the thin photoresist layer covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device. Specification, page 5, line 6; Specification, page 5, lines 10-13; Figure 3, step 308; Figure 4, elements 400, 402, 404 and 406. The system may further comprise means for providing the halo implant to the semiconductor device, where the thin photoresist layer is used as a mask. Specification, page 5, lines 6-9; Figure 3, step 308; Figure 2, element 202; Figure 4, element 400.

In another embodiment of the present invention, a semiconductor device may comprise a gate. Specification, page 4, lines 9-11; Figure 4, elements 200, 208, 400. The system may further comprise an oxide trench. Specification, page 4, lines 16-20; Figure 2, element 207. The system may further comprise a drain region adjacent to the oxide trench. Specification, page 5, lines 11-13; Figure 4, element 406. The system may further comprise a source region adjacent to the oxide trench. Specification, page 5, lines 11-13; Figure 4, element 404. The system may further comprise a photoresist layer of a thickness between .1 μm to .2 μm over the oxide trench and a substantial portion of the source and the drain region, where a halo implant is implanted using the photoresist layer and the gate as a mask. Specification, page 5, lines 6-13; Figure 3, step 308; Figure 2, elements 202 and 208; Figure 4, elements 400, 402, 404 and 406.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 4-5, 8 and 11-12 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Hori et al. (U.S. Patent No. 5,320,974) (hereinafter "Hori") in view of Wolf et al. ("Silicon Processing for the VLSI Era, Volume 1: Process Technology", Lattice Press, 1986, pp. 321-324) (hereinafter "Wolf"). Claims 7 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and

in further view of Thackeray et al. (U.S. Patent No. 6,037,107). Claim 18 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Liang et al. (U.S. Patent No. 6,051,458) in view of Wolf et al. ("Silicon Processing for the VLSI Era, Volume 1-Process Technology", pp. 321-324) (hereinafter "Wolf"). Claim 19 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf and in further view of Thompson et al. (U.S. Patent No. 6,020,244) (hereinafter "Thompson"). Claim 20 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf and in further view of Thackeray et al. (U.S. Patent No. 6,037,107) (hereinafter "Thackeray").

VII. ARGUMENT

A. Claims 1, 4-5, 8 and 11-12 are not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf.

The Examiner has rejected claims 1, 4-5, 8 and 11-12 under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf. Paper No. 28, page 2. Appellants respectfully traverse these rejections for at least the reasons stated below.

1. By combining Hori with Wolf, the principle of operation of Hori would change.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 370 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959). Further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by combining Hori with Wolf, the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily.

Hori teaches forming sidewall spacers, spacers 5a and 5b, made of silicon nitride film. Column 6, lines 27 through 29. Hori further teaches that the exposed portions of a silicon oxide film, silicon oxide film 3, on the silicon substrate are removed so as to expose the silicon substrate thereunder. Column 6, lines 29-31. Hori further teaches that arsenic ions are implanted into the substrate using the gate electrode and sidewall spacers, spacers 5a and 5b, as a mask thereby forming an n^+-type source region and an n^+-type drain region. Column 6, lines 31-36. Hori further teaches depositing a titanium film with a thickness of 40 to 60 nanometers on the top surface of the substrate. Column 6, lines 37 – 39. Hori further teaches a heat treatment at a temperature of 600° C to 850° C is conducted to allow the titanium film to react with the silicon substrate thereby <u>forming titanium silicide films 8a, 8b, and 8c with a thickness of 60 to 100 nanometers</u>, respectively. Column 6, lines 39-44. Hori further teaches that since the titanium film does not react with the silicon nitride film, the titanium films on the sidewall spacers, spacers 5a and 5b, remain unreacted. Column 6, lines 44 – 47. Hori further teaches that sidewall spacers, spacers 5a and 5b, are removed by a dry etching using an etching gas. Column 6, lines 50-52. Hori further teaches that <u>boron ions are implanted using the gate electrode and the titanium silicide films 8a and 8b on the source and drain regions as a mask</u>. Column 6, lines 53-56. Hori further teaches that p^+-type semiconductor regions 10a and 10b are formed as punch through stoppers. Column 6, lines 62-64. Hori further teaches that <u>since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate</u>. Column 6, lines 64-68. Hori further teaches that <u>as a result of the above-outlined process, p^+-type semiconductor regions 10a and 10b are formed only in a channel region</u>. Column 6, line 68 – column 7, line 2. Hori further teaches that by not forming the p^+-type semiconductor regions 10a and 10b under the n^+ - type source and drain regions it is possible to obtain the high speed semiconductor transistor device with a small

parasitic junction capacitance and a low impurity concentration in the center of the channel region. Column 7, lines 22-29.

Wolf, on the other hand, teaches that an appropriate mask layer needs to be present on the wafer surface to restrict the ionic species from being implanted into unwanted substrate regions. Page 321. Wolf further teaches that many materials are used for such masking purposes in IC fabrication including photoresist, SiO_2, Si_3N_4, polysilicon, metal films and polyimide. Page 321.

By combining Hori with Wolf, Hori would no longer be able to form the p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. As stated above, Hori teaches using titanium silicide films 8a and 8b on the source and drain regions as a mask. Hori further teaches that since the <u>ion stopping power of titanium silicide is about 1.5 times higher than that of silicon</u>, <u>the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate</u>. Wolf, on the other hand, teaches using a photoresist as a mask. The Examiner has not provided any evidence that would suggest that a photoresist, with the same thickness as titanium silicide, would have an ion stopping power similar to titanium silicide which is about 1.5 times higher than that of silicon. In fact, a photoresist has a much lower ion stopping power than titanium silicide and even lower than that of silicon. Appellants respectfully refer the Examiner to the periodic table of elements which indicates that silicon has an atomic number of 14, carbon has an atomic number of 6, and titanium has an atomic number of 81. The greater the number of the atomic number, i.e., the greater number of protons in the nucleus and the number of electrons orbiting the nucleus, the greater the ion stopping power. Since the atomic number of carbon, which a photoresist is mainly comprised of, is lower than the atomic number of silicon, one may conclude that the ion stopping

power of a photoresist is less than that of silicon. Hence, by replacing titanium silicide with a photoresist of the same thickness, the ion stopping power will be less than that of silicon and hence not be able to prevent boron ions from permeating near pn–junctions between the n^+-type source and drain regions and the substrate. Hence, by combining Hori with Wolf, Hori would no longer be able to form p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Thus, by combining Hori with Wolf, the principle of operation in Hori would change, and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

In response to Appellants' above argument, the Examiner asserts that both SiO_2 and photoresist have the ability to stop 99.99% of ionic species for a given thickness as illustrated in Figures 36(a) and (b) of Wolf. Paper No. 26, page 8. The Examiner further states that the comparison between SiO_2 and photoresist is not necessary. Paper No. 26, page 8.

Appellants respectfully disagree with the Examiner that the comparison is not necessary. The Examiner is combining Hori with Wolf in his rejection of claims 1, 4-5, 7-8, 11-12 and 14. The Examiner cannot combine Hori with Wolf if the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily. By combining Hori with Wolf, titanium silicide films 8a and 8b on the source and drain regions in Hori would be replaced with photoresist. Hence, the comparison between SiO_2 and photoresist is necessary.

Further, Appellants direct the Examiner's attention to Figures 36(a) and (b) of Wolf which indicate that the thickness of photoresist must be greater than the thickness of silicon dioxide to stop the same percent of incident ions. Hori specifies that the titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. Hori further teaches that the boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as a mask. Column 6, lines 53-54. If a photoresist replaced titanium silicide films 8a and 8b with the same thickness, then boron ions are allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate (contrary to the principle of operation of Hori). Hori specifically selected titanium silicide over silicon because of its better ion stopping power. As stated above, Hori selected titanium silicide in order to form the p+ -type semiconductor regions only in a channel region. Column 7, lines 1-2. Presumably, Hori could have used silicon instead of titanium silicide but with a greater thickness than 60 to 100nm (thickness of titanium silicide) in order to have the same ion stopping power as suggested by the Examiner. As stated above, the Examiner suggests that Hori could replace titanium silicide with photoresist but at an additional thickness in order to have the same ion stopping power. However, Hori did not substitute titanium silicide with silicon, in part, because of the additional thickness which would affect the implantation of the boron ions. Hori teaches that the boron ions are implanted into a substrate at such a large angle (an angle of ion beams to a normal line of a main surface of the substrate) as 20 to 60 degrees, preferably 25 to 45 degrees. Column 6, lines 56-61. By replacing titanium silicide with photoresist and consequently increasing the thickness of the mask, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). This would change the principle of operation in Hori and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the

Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

2. <u>Hori and Wolf, taken singly or in combination, do not teach or suggest the following claim limitations.</u>

Appellants respectfully assert that Hori and Wolf, taken singly or in combination, do not teach or suggest "providing a thin photoresist layer" as recited in claim 1 and similarly in claim 8. The Examiner cites page 321 of Wolf as teaching the above-cited claim limitation. Paper No. 28, page 3. Appellants respectfully traverse and assert that Wolf instead teaches using a photoresist as a mask layer to restrict the ionic species from being implanted into unwanted substrate regions. However, the language in the cited passage does not specifically state using a thin photoresist layer. Further, the Examiner has not provided any objective evidence for modifying Hori to provide a thin photoresist layer. The Examiner must provide objective evidence and not rely on his own subjective opinion in support of modifying Hori to provide a thin photoresist layer. *In re Lee*, 61 U.S.P.Q.2d 1430, 1434 (Fed. Cir. 2002). Therefore, the Examiner has not presented a *prima facie* case of obviousness, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet,* 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

B. <u>Claims 7 and 14 are not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and in further view of Thackeray.</u>

The Examiner has rejected claims 7 and 14 under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and in further view of Thackeray. Paper No. 28, page 4. Appellants respectfully traverse these rejections for at least the reason that the combination of Hori with Wolf would change the principle of operation as discussed above on pages 4-9 and that Hori and Wolf, taken singly or in combination,

do not teach or suggest all of the limitations in claims 1 and 8 as discussed above on page 9. Appellants also respectfully traverse these rejections for at least the reasons stated below.

As stated above, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 370 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959). Further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by combining Hori with Thackeray, the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily.

As stated above, Hori teaches forming sidewall spacers, spacers 5a and 5b, made of silicon nitride film. Column 6, lines 27 through 29. Hori further teaches that the exposed portions of a silicon oxide film, silicon oxide film 3, on the silicon substrate are removed so as to expose the silicon substrate thereunder. Column 6, lines 29-31. Hori further teaches that arsenic ions are implanted into the substrate using the gate electrode and sidewall spacers, spacers 5a and 5b, as a mask thereby forming an n^+-type source region and an n^+-type drain region. Column 6, lines 31-36. Hori further teaches depositing a titanium film with a thickness of 40 to 60 nanometers on the top surface of the substrate. Column 6, lines 37 – 39. Hori further teaches a heat treatment at a temperature of 600° C to 850° C is conducted to allow the titanium film to react with the silicon substrate thereby forming titanium silicide films 8a, 8b, and 8c with a thickness of 60 to 100 nanometers, respectively. Column 6, lines 39-44. Hori further teaches that since the titanium film does not react with the silicon nitride film, the titanium films on the sidewall spacers, spacers

5a and 5b, remain unreacted. Column 6, lines 44 – 47. Hori further teaches that sidewall spacers, spacers 5a and 5b, are removed by a dry etching using an etching gas. Column 6, lines 50-52. Hori further teaches that boron ions are implanted using the gate electrode and the titanium silicide films 8a and 8b on the source and drain regions as a mask. Column 6, lines 53-56. Hori further teaches that p^+-type semiconductor regions 10a and 10b are formed as punch through stoppers. Column 6, lines 62-64. Hori further teaches that since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate. Column 6, lines 64-68. Hori further teaches that as a result of the above-outlined process, p^+-type semiconductor regions 10a and 10b are formed only in a channel region. Column 6, line 68 – column 7, line 2. Hori further teaches that by not forming the p^+-type semiconductor regions 10a and 10b under the n^+ - type source and drain regions it is possible to obtain the high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Column 7, lines 22-29.

Thackeray, on the other hand, teaches a photoresist composition comprising a resin binder having acid labile blocking groups requiring an activation energy in excess of 20 Kcal/mol. for deblocking, a photoacid generator capable of generating a halogenated sulfonic acid upon photolysis and optionally a base additive. Abstract.

By combining Hori with Thackeray, Hori would no longer be able to form the p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. As stated above, Hori teaches using titanium silicide films 8a and 8b on the source and drain regions as a mask. Hori further teaches that since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not

allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate. Thackeray, on the other hand, teaches a photoresist composition. The Examiner has not provided any evidence that would suggest that a photoresist, with the same thickness as titanium silicide, would have an ion stopping power similar to titanium silicide which is about 1.5 times higher than that of silicon. In fact, a photoresist has a much lower ion stopping power than titanium silicide and even lower than that of silicon. Appellants respectfully refer the Examiner to the periodic table of elements which indicates that silicon has an atomic number of 14, carbon has an atomic number of 6, and titanium has an atomic number of 81. The greater the number of the atomic number, i.e., the greater number of protons in the nucleus and the number of electrons orbiting the nucleus, the greater the ion stopping power. Since the atomic number of carbon, which a photoresist is mainly comprised of, is lower than the atomic number of silicon, one may conclude that the ion stopping power of a photoresist is less than that of silicon. Hence, by replacing titanium silicide with a photoresist of the same thickness, the ion stopping power will be less than that of silicon and hence not be able to prevent boron ions from permeating near pn–junctions between the n^+-type source and drain regions and the substrate. Hence, by combining Hori with Thackeray, Hori would no longer be able to form p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Thus, by combining Hori with Thackeray, the principle of operation in Hori would change, and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Further, as stated above, Appellants direct the Examiner's attention to Figures 36(a) and (b) of Wolf which indicate that the thickness of photoresist must be greater than the thickness of silicon dioxide to stop the same percent of incident ions. Hori specifies that the titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. Hori further teaches that the boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as a mask. Column 6, lines 53-54. If a photoresist replaced titanium silicide films 8a and 8b with the same thickness, then boron ions are allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate (contrary to the principle of operation of Hori). Hori specifically selected titanium silicide over silicon because of its better ion stopping power. As stated above, Hori selected titanium silicide in order to form the p+ -type semiconductor regions only in a channel region. Column 7, lines 1-2. Presumably, Hori could have used silicon instead of titanium silicide but with a greater thickness than 60 to 100nm (thickness of titanium silicide) in order to have the same ion stopping power as suggested by the Examiner. As stated above, the Examiner suggests that Hori could replace titanium silicide with photoresist but at an additional thickness in order to have the same ion stopping power. However, Hori did not substitute titanium silicide with silicon, in part, because of the additional thickness which would affect the implantation of the boron ions. Hori teaches that the boron ions are implanted into a substrate at such a large angle (an angle of ion beams to a normal line of a main surface of the substrate) as 20 to 60 degrees, preferably 25 to 45 degrees. Column 6, lines 56-61. By replacing titanium silicide with photoresist and consequently increasing the thickness of the mask, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). This would change the principle of operation in Hori and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the

Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

As a result of the foregoing, Appellants respectfully assert that the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14 as being unpatentable over Hori in view of Wolf and in further view of Thackeray. M.P.E.P. §2143.

C. <u>Claim 18 is not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf.</u>

The Examiner has rejected claim 18 under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf. Paper No. 31, page 5. Appellants respectfully traverse for at least the reasons stated below.

1. <u>By modifying Liang to have a photoresist layer with a thickness between .1 μm and .2 μm, the principle of operation of Liang would change.</u>

The Examiner admits that Liang does not teach a photoresist layer with a thickness between .1 μm and .2 μm, which is a limitation required in claim 18. Paper No. 31, page 5. The Examiner then cites Wolf as support for modifying Liang to have a photoresist layer with a thickness between .1 μm and .2 μm in order to restrict the ionic species from being implanted into unwanted substrate regions. Paper No. 31, page 6. If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by modifying Liang to have a photoresist layer with a thickness between .1 μm and .2 μm, the principle of operation in Liang would change and subsequently render the operation of Liang to perform its purpose unsatisfactorily.

Liang teaches that ions (element 26' in Figure 1C), comprising boron or boron difluoride are ion implanted into LDS/LDD regions (elements 26S/26D in Figure 1C) with a dose from about 1 E 13 ions/cm^2 to about 5 E 14 ions/ cm^2 at an energy from about 15 keV to about 50 keV. Column 3, lines 34-37.

Wolf, on the other hand, teaches a relationship between the thickness of the photoresist in order to stop 99.99% of incident ions (Boron, Phosphorous and Arsenic) at various kinetic energy levels of the implanted ion. Page 322. The Examiner presumably cites this passage to assert that in order to restrict the ionic species from being implanted into unwanted substrate regions (Examiner's motivation), 99.99% of the incident ions need to be stopped. Referring to Figure 36 on page 322 of Wolf, Wolf illustrates that the thickness of the photoresist to stop 99.99% of boron ions at an energy from about 15 keV to about 50 keV (implant energy cited by Liang) requires a thickness much greater than .2 μm. In fact, in order to stop 99.99% of boron ions at an energy of about 50 keV, the thickness of the photoresist should be at least .3 μm.

If Liang were modified to have a photoresist with a thickness between .1 μm and .2 μm, then Liang would not be able to stop 99.99% of boron ions at the implant energy levels cited in Liang. Hence, Liang would not be able to restrict the ionic species from being implanted into unwanted substrate regions as asserted by the Examiner. Thus, by modifying Liang with Wolf to have a photoresist layer with a thickness between .1 μm and .2 μm in order to restrict the ionic species from being implanted into unwanted substrate regions, the principle of operation in Liang would change, and subsequently render the operation of Liang to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 18-20. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

2. <u>Liang and Wolf, taken singly or in combination, do not teach or suggest the following claim limitations.</u>

Appellants respectfully assert that Liang and Wolf, taken singly or in combination, do not teach or suggest "an oxide trench; a drain region adjacent to said oxide trench; a source region adjacent to said oxide trench" as recited in claim 18. The Examiner cites elements 14A and 14B of Liang as teaching two different oxide trenches; element 24D of Liang as teaching a drain region; and element 24S of Liang as teaching a source region. Paper No. 31, page 5. Appellants respectfully traverse that Liang teaches the above-cited claim limitations.

Liang instead teaches a lightly doped drain region (element 24D as illustrated in Figure 1C) adjacent to a first shallow trench isolation (STI) structure (element 14B as illustrated in Figure 1C) and a lightly doped source region (element 24S as illustrated in Figure 1C) adjacent to a second STI structure (element 14A as illustrated in Figure 1C). Claim 18 recites an oxide trench where a drain region and a source region <u>are adjacent to that oxide trench</u>. <u>The claim does not recite two separate oxide trenches</u>. All words in a claim must be considered in judging the patentability of that claim against the prior art. *In re Wilson*, 424 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970); M.P.E.P. §2143.03. Liang does not teach a source and a drain region adjacent to the same oxide trench. Therefore, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 18, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

Appellants further assert that Liang and Wolf, taken singly or in combination, do not teach or suggest "a photoresist layer of a thickness between .1 μm and .2 μm over said oxide trench and a substantial portion of said source and drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask" as recited in claim 18. The Examiner cites element PR2 of Liang as teaching a photoresist layer; element 24D of Liang as teaching a drain region; element 24S of

Liang as teaching a source region; and elements 14A and 14B as teaching the oxide trench. Paper No. 31, page 5. Appellants respectfully traverse.

Liang instead teaches that mask PR2 overlies all of STI structure 14A but only a portion of STI structure 14B. If the Examiner is citing STI structure 14B as teaching the oxide trench as recited in claim 18, then the mark PR2 does not cover the oxide trench as required by claim 18. Furthermore, as illustrated in Figure 1C, the mask PR2 does not cover a substantial portion of element 24S (Examiner asserts that element 24S teaches a source region). Instead, the mask PR2 covers an insubstantial portion of element 24S. Hence, Liang does not teach a photoresist layer covering a substantial portion of a source region. Neither does the mask PR2 cover a substantial portion of element 24D (Examiner asserts that element 24D teaches a drain region). Therefore, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 18, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

D. <u>Claim 19 is not properly rejected under 35 U.S.C. 103(a) as being unpatentable over Liang in view of Wolf and in further view of Thompson</u>

The Examiner has rejected claims 19 under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf and in further view of Thompson. Paper No. 31, page 6. Appellants respectfully traverse for at least the reasons stated below.

1. <u>Liang, Wolf and Thompson, taken singly or in combination, do not teach or suggest the following claim limitations.</u>

Appellants respectfully assert that Liang, Wolf and Thompson, taken singly or in combination do not teach or suggest "wherein said halo implant is implanted at a substantially 45 degree angle" as recited in claim 19. The Examiner cites column 3, lines 18-19 of Thompson as teaching the above-cited claim limitation. Paper No. 31, page 6. Appellants respectfully traverse.

Thompson instead teaches that in prior art, halo regions (elements 15 and 16 of Figure 1) are formed by ion implantation prior to the doping of the source and drain regions by implanting a relatively heavy p-type dopant at two different angles so that the dopant lodges as illustrated in Figure 1. Column 2, lines 15-19. Thompson further teaches that instead of the halo regions of Figure 1, the region (element 25 in Figure 2) is used in accordance with the present invention in the transistor of Figure 2. Column 2, lines 45-47. Thompson further teaches that Figure 3 illustrates the fabrication of region 25 (Figure 2). Column 2, lines 62-63. Thompson further teaches that a step in the fabrication of region 25 that replaces the halo regions of Figure 1 is the implantation of a dopant (see elements 35 and 36 of Figure 3) at an angle of 30° or greater. Column 3, lines 18-19. Hence, Thompson does not teach implanting a halo implant at an angle of 30° or greater. In fact, Thompson teaches the antithesis of implanting a halo implant. Thompson specifically teaches that it does not implant a halo implant as the purpose of Thompson is to form a region to replace the halo regions as used in prior art. Therefore, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 19, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

2. By combining Liang with Thompson, the principle of operation of Liang would change.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 370 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959). Further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by combining Liang with

Thompson, the principle of operation in Liang would change and subsequently render the operation of Liang to perform its purpose unsatisfactorily.

Liang teaches that an objection of the invention is to reduce drain breakdown voltage to increase substrate current without degrading punchthrough effect. Column 1, lines 50-52. Liang further teaches that a key feature of the invention is a counter doped halo region for the source region with drain halo regions in an ESD transistor. Column 1, lines 55-57. Liang further teaches that in step 44, as illustrated in Figure 1C, a mask PR2 is formed with windows W2L and W2R. Column 3, lines 21-22. Liang further teaches that the window W2L is used to form halo implants of a p-type dopant into a p-well on either side of the gate electrode stack below the lightly doped source and drain regions. Column 3, lines 28-31.

Thompson, on the other hand, teaches that in prior art, halo regions (elements 15 and 16 of Figure 1) are formed by ion implantation prior to the doping of the source and drain regions by implanting a relatively heavy p-type dopant at two different angles so that the dopant lodges as illustrated in Figure 1. Column 2, lines 15-19. Thompson further teaches that instead of the halo regions of Figure 1, the region (element 25 in Figure 2) is used in accordance with the present invention in the transistor of Figure 2. Column 2, lines 45-47. Thompson further teaches that Figure 3 illustrates the fabrication of region 25 (Figure 2). Column 2, lines 62-63. Thompson further teaches that a step in the fabrication of region 25 that replaces the halo regions of Figure 1 is the implantation of a dopant (see elements 35 and 36 of Figure 3) at an angle of 30° or greater. Column 3, lines 18-19. Hence, Thompson teaches away from implanting halo regions.

By combining Liang with Thompson, the principle of operation of Liang would change, and subsequently render the operation of Liang to perform its purpose unsatisfactorily. As stated above, Thompson teaches forming a region (element 25 in Figure 2) to replace halo implants. By combining Liang with Thompson, Liang

would no longer be able to form halo implants of a p-type dopant into a p-well on either side of the gate electrode stack below the lightly doped source and drain regions. By not being able to form halo implants, Liang would not be able to provide a counter doped halo region for the source region with drain halo regions in an ESD transistor thereby not being able to reduce drain breakdown voltage to increase substrate current, which is an object of the invention. Thus, by combining Liang with Thompson, the principle of operation in Liang would change, and subsequently render the operation of Liang to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 19. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

3. <u>The Examiner's motivation is insufficient to support a *prima facie* case of obviousness in rejecting claim 19.</u>

A *prima facie* showing of obviousness requires the Examiner to establish, *inter alia*, that the prior art references teach or suggest, either alone or in combination, all of the limitations of the claimed invention, and the Examiner must provide a motivation or suggestion to combine or modify the prior art reference to make the claimed inventions. M.P.E.P. § 2142. The showings must be clear and particular and supported by objective evidence. *In re Lee*, 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430, 1433-34 (Fed. Cir. 2002); *In re Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000); *In re Dembiczak*, 50 U.S.P.Q.2d. 1614, 1617 (Fed. Cir. 1999). Broad conclusory statements regarding the teaching of multiple references, standing alone, are not evidence. *Id.*

The Examiner's motivation for modifying Liang with Thompson to implant a halo implant at a substantially 45 degree angle, as recited in claim 19, is "to improve punchthrough characteristics (col. 1, lines 40-41)." Paper No. 31, page 7. This

motivation is insufficient to support a *prima facie* case of obviousness as discussed below.

The Examiner's motivation does not address as to why one of ordinary skill in the art would modify Liang to implant a halo implant at a substantially 45 degree angle. The Examiner's motivation (Examiner cited column 1, lines 40-41 of Thompson) does not relate to implanting a halo implant. Instead, the Examiner's motivation is directed to implanting an ion in a region to replace halo regions. As stated above, Thompson teaches that in prior art, halo regions (elements 15 and 16 of Figure 1) are formed by ion implantation prior to the doping of the source and drain regions by implanting a relatively heavy p-type dopant at two different angles so that the dopant lodges as illustrated in Figure 1. Column 2, lines 15-19. Thompson further teaches that instead of the halo regions of Figure 1, the region (element 25 in Figure 2) is used in accordance with the present invention in the transistor of Figure 2. Column 2, lines 45-47. Thompson further teaches that Figure 3 illustrates the fabrication of region 25 (Figure 2). Column 2, lines 62-63. Thompson further teaches that a step in the <u>fabrication of region 25 that replaces the halo regions of Figure 1 is the implantation of a dopant (see elements 35 and 36 of Figure 3) at an angle of 30° or greater</u>. Column 3, lines 18-19. Thompson further teaches that the devices of the present invention will have a higher concentration of the dopant and consequently <u>improved punchthrough characteristics</u>. Column 1, lines 40-41. Thompson further teaches that <u>this is achieved by ion implanting at approximately 30° or greater prior to the formation of the source and drain regions</u>. Column 1, lines 42-44. Thus, Thompson teaches that punchthrough characteristics are improved by replacing halo regions with a region where the fabrication of that region includes the step of implanting an ion at approximately 30° or greater. Hence, this motivation is not directed to implanting a halo implant. A *prima facie* case of obviousness requires the Examiner to provide some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art

to modify Liang to implant a halo implant at a substantially 45 degree angle. M.P.E.P. §2143. As the Examiner has not presented such motivation, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 19. M.P.E.P. §2143.

E. Claim 20 is not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf and in further view of Thackeray.

The Examiner has rejected claim 20 under 35 U.S.C. §103(a) as being unpatentable over Liang in view of Wolf and in further view of Thackeray. Paper No. 31, page 7. Appellants respectfully traverse these rejections for at least the reasons stated below.

As stated above, a *prima facie* showing of obviousness requires the Examiner to establish, *inter alia*, that the prior art references teach or suggest, either alone or in combination, all of the limitations of the claimed invention, and the Examiner must provide a motivation or suggestion to combine or modify the prior art reference to make the claimed inventions. M.P.E.P. § 2142. The showings must be clear and particular and supported by objective evidence. *In re Lee*, 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430, 1433-34 (Fed. Cir. 2002); *In re Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000); *In re Dembiczak*, 50 U.S.P.Q.2d. 1614, 1617 (Fed. Cir. 1999). Broad conclusory statements regarding the teaching of multiple references, standing alone, are not evidence. *Id.*

The Examiner's motivation for modifying Liang with Thackeray to have a photoresist layer that comprises a deep ultraviolet layer, as recited in claim 20, is "to effectively activate the photoactive component of the photoresist system (see col. 12, lines 60-62 and col. 13, lines 1-6)." Paper No. 31, page 7. This motivation is insufficient to support a *prima facie* case of obviousness as discussed below.

The Examiner's motivation is not evidence as to why one of ordinary skill in the art, with the reference Liang in front of him, would have been motivated to

modify Liang with the teachings of Thackeray. The Examiner's motivation is instead a motivation for Thackeray to solve its problem as discussed below.

Thackeray teaches that linewidth variation is unacceptable for most commercial applications. Column 3, lines 24-25. Thackeray further teaches that it would be desirable to have chemically amplified photoresist compositions capable of providing high resolved fine line images, including images of submicron and sub half-micron dimension, which are PEB insensitive. Column 3, lines 25-29. Thackeray further teaches that it would be desirable to having such a chemically amplified photoresist where variation in linewidth as a function of post exposure bake temperature is reduce or eliminated. Column 3, lines 29-32. Thackeray further teaches that following coating of the photoresist onto a surface, it is dried by heating to remove the solvent until preferably the photoresist coating is tack free. Column 12, lines 57-59. Thackeray further teaches that it is imaged through a mask in a conventional manner. Column 12, lines 59-60. Thackeray further teaches that the exposure is sufficient to effectively activate the photoactive component of the photoresist system, i.e., <u>generate sufficient acid</u> to produce a patterned image in the resist coating layer following post exposure bake. Column 12, lines 60-64. Thackeray further teaches that the photoresists of the invention comprise a photoacid generator that liberates a halogenated sulfonic acid upon photolysis. Column 4, lines 6-8. Thackeray further teaches that it has been found that PEB sensitivity as a consequence of a high temperature bake is substantially reduced when using the halogenated sulfonic acid generator. Column 3, lines 41-44. Hence, Thackeray teaches that linewidth variation across a wafer may be reduced (problem to be solved in Thackeray) by effectively activating the photoactive component of the photoresist system (Examiner's motivation), i.e., generate sufficient acid to produce a patterned image in the resist coating layer following post exposure bake. Thus, the Examiner's motivation is directed to solving the problem presented in Thackeray.

The Examiner, however, must provide objective evidence as to why one of ordinary skill in the art would modify Liang with Thackeray to have a photoresist layer that comprises a deep ultraviolet layer. *In re Lee*, 61 U.S.P.Q.2d 1430, 1433-1434 (Fed. Cir. 2002); *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1318 (Fed. Cir. 2000). Merely stating motivation for Thackeray to solve its problem is not evidence for modifying Liang with Thackeray to have a photoresist layer that comprises a deep ultraviolet layer. *In re Lee*, 61 U.S.P.Q.2d 1430, 1434 (Fed. Cir. 2002). Consequently, the Examiner's motivation is insufficient to support a *prima facie* case of obviousness for rejecting claim 20. *Id.*

VIII. CONCLUSION

For the reasons noted above, the rejections of claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 are in error. Appellant respectfully requests reversal of the rejections and allowance of claims 1, 4-8, 11, 12 and 14-20.

Respectfully submitted,

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CLAIMS APPENDIX

1. A method for providing a halo implant to a semiconductor device comprising the steps of:

(a) providing a thin photoresist layer to the semiconductor device that covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device; and

(b) providing the halo implant to the semiconductor device, wherein the thin photoresist layer is used as a mask.

4. The method as recited in claim 1 wherein the halo implant is at approximately 45° angle.

5. The method of claim 1 which includes the step of providing a lightly doped drain implant before the halo implant providing step (b).

7. The method of claim 1 wherein the photoresist layer comprises a deep ultraviolet (DUV) layer.

8. A system for providing a halo implant to a semiconductor device comprising:

means for providing a thin photoresist layer to the semiconductor device, wherein the thin photoresist layer covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device; and

means for providing the halo implant to the semiconductor device, wherein the thin photoresist layer is used as a mask.

11. The system as recited in claim 8 wherein the halo implant is at approximately 45° angle.

12. The system of claim 8 which includes the step of providing a lightly doped drain implant before the halo implant providing step (b).

14. The system of claim 8 wherein the photoresist layer comprises a deep ultraviolet (DUV) layer.

15. A method for implanting a halo implant in a semiconductor device comprising the steps of:

providing a first photoresist layer of a thickness 0.55 μm or greater over an oxide trench of said semiconductor device;

providing a lightly doped drain implant;

removing said first photoresist layer;

providing a second photoresist layer of a thickness between .1 μm to .2 μm over said oxide trench and a substantial portion of a source and a drain region; and

implanting a halo implant using said second photoresist layer as a mask.

16. The method as recited in claim 15, wherein said halo implant is implanted at a substantially 45 degree angle.

17. The method as recited in claim 15, wherein said second photoresist layer comprises a deep ultraviolet layer.

18. A semiconductor device, comprising:

a gate;

an oxide trench;

a drain region adjacent to said oxide trench;

a source region adjacent to said oxide trench; and

a photoresist layer of a thickness between .1 μm to .2 μm over said oxide trench and a substantial portion of said source and said drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask.

19. The semiconductor device as recited in claim 18, wherein said halo implant is implanted at a substantially 45 degree angle.

20. The semiconductor device as recited in claim 18, wherein said photoresist layer comprises a deep ultraviolet layer.

EVIDENCE APPENDIX

No evidence was submitted pursuant to §§1.130, 1.131, or 1.132 of 37 C.F.R. or of any other evidence entered by the Examiner and relied upon by Appellant in the Appeal.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings to the current proceeding.